Chapter 20: Baseline Conditions in Ohio

INTRODUCTION

Section IV of this EEBA focuses on the State of Ohio as a case study of the MP&M regulation's expected benefits and costs. Ohio has a diverse water resource base, a relatively large number of MP&M industry facilities, and a more extensive water quality ecological database than many other states. EPA gathered extensive data on MP&M facilities and on Ohio's baseline water quality conditions and water-based recreation activities, to support the case study analysis. These data characterize current water quality conditions, water quality changes expected from the regulation, and the expected welfare changes from water quality improvements at waterbodies affected by MP&M discharges.

The case study analysis supplements the national level analysis performed for the MP&M regulation in two important ways. First, the case study used improved data and methods to determine MP&M pollutant discharges from both MP&M facilities and other sources. In particular, EPA oversampled the State of Ohio with 1,600 screener questionnaires to augment information on Ohio MP&M facilities. The Agency also used information from the sampled MP&M facilities to assign discharge characteristics to non-sampled MP&M facilities[1]. Second, the analysis used an original travel cost study to value four recreational uses of water resources affected by the regulation: swimming, fishing, boating, and near-water activities. The added detail provides a more complete and reliable analysis of water quality changes from reduced MP&M discharges. The case study analysis therefore provides more complete estimates of changes in human welfare resulting from reduced health risk, enhanced recreational opportunities, and improved economic productivity.

The statewide case study of recreational benefits from the MP&M regulation combines water quality modeling with a **_random utility model_ (RUM)** to assess how changes in water quality from the regulation will affect consumer valuation of water resources. The study addresses a wide

range of pollutant types and effects, including water quality measures not often addressed in past recreational benefits studies. The estimated model supports a more complete analysis of recreational benefits from reductions in **_nutrients_** and "**_toxic_**" pollutants.[2]

This and the next two chapters present the Ohio case study. This chapter provides background information on the state of Ohio, the following chapter presents the results from the

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[1] Appendix G provides a detailed discussion on the approach used to estimate discharge characteristics for non-sampled MP&M facilities.

[2] The term "toxic" used here refers to the 126 **_priority or toxic pollutants_** specifically defined as such by EPA, as well as **_nonconventional pollutants_** that have a toxic effect on human health or aquatic organisms.

recreational benefits analysis, and the last chapter summarizes social costs and benefits of the proposed regulation for the state of Ohio.

20.1 OVERVIEW OF OHIO'S GEOGRAPHY, POPULATION, AND ECONOMY

Table 20.1 summarizes general information on Ohio. Ohio is large, heavily-industrialized, and densely-populated. The state covers a total surface area of 44,828 sq. mi. (106,607 sq. km.), of which water represents 3,875 sq. mi. (10,036 sq. km.). About 90 percent of the water surface area consists of Lake Erie; the remainder includes inland waters, such as lakes, reservoirs, and rivers (including the Ohio River). The state housed 11,173,000 people in 1996. The three largest metropolitan areas are located on Lake Erie (Toledo and Cleveland) and the Ohio River (Cincinnati).

Table 20.1: Facts about the State of Ohio		
Geography		
Location	Midwest United States, northeast part: • south of Lake Erie • east of Indiana • north of the Ohio River	
Total land area	40,953 sq. mi. (106,607 sq. km.) Of the 26,451,000 acres of terrestrial surface area in Ohio: • 97 percent is non-federal land (National Resources Inventory (NRI)) • 3,558,000 acres, representing 13.5 percent of the total area of Ohio, are developed The remaining non-federal lands are rural land, classified mostly as crop land, forest, and pasture lands. (USDA, 1992)	
Total water surface area	3,875 sq. mi. (10,036 sq. km.) Approx. 90 percent is represented by Lake Erie, and 10 percent are inland waters including rivers, lakes, and reservoirs.[a]	
Total area	44,828 sq. mi. (116,104 sq. km.)	
Demographics		
Population	11,173,000 in 1996, approximately 4.2 percent of total U.S. population (U.S. Census Bureau) Population increase: three percent from 1990 to 1996, compared to a six percent increase in the U.S. population overall. Most densely populated part of the state: northeastern Ohio, both urban and rural areas. Largest cities: Cleveland, Cincinnati, and Toledo.	
Economics		
	Ohio	**Midwest**	**U.S.**
Per Capita Income (1996$)	$23,537 Rank in per capital income in the U.S.: 21	$24,166	$24,231
Percent of population below the poverty level (1995 Current Population Survey data, DOC 1996)	11.5%		13.8%
	Ohio per capita income increased by 16 percent from 1986 to 1996. Income growth is consistent with other Midwestern states and is two percent greater than overall U.S. per capita income growth.		
Gross State Product (GSP)	$303,569,000 (1996$), representing 4 percent of Gross Domestic Product (GDP) for the U.S. in 1996.		
Percent increase in GSP/GDP from 1986 to 1996 (in adjusted 1996$)	Ohio GSP		U.S. GDP
	25%		29%

a. Total water surface uses are estimated by the USDA's National Resources Inventory (NRI). See "http://www.ftw.nrcs.usda.gov/nri_data.html"
Source: U.S. EPA analysis.

20.2 PROFILE OF MP&M FACILITIES IN OHIO

EPA selected Ohio as the case study state because MP&M industries account for a large share of the state's economy (see Table 20.2). Data from the 1992 Economic Censuses show that industries containing MP&M facilities employ

16.5 percent of Ohio's total industrial workers and produce 20.4 percent of industrial worker output by value. MP&M industries also account for 21.9 percent of payroll payments, indicating that jobs in MP&M industries are more highly paid than industrial jobs on average in Ohio. The discussion below explains the sources and methodology EPA used, and then presents detailed results and caveats.

Table 20.2: MP&M Share of Industrial Output and Employment in Ohio, 1992			
	Total Employment	**Payroll**	**Value of Output**
MP&M	615,706	$18,667,630,000	$111,052,845,000
TOTAL	3,723,809	$85,085,182,000	$544,340,216,000
MP&M Share	**16.5%**	**21.9%**	**20.4%**

Source: Department of Commerce 1992 Economic Censuses.

EPA obtained employment, payroll, and output data from the 1992 Economic Census CD-ROM, drawing from the eight economic censuses in Table 20.3. Employment and payroll numbers include all employees (i.e., production plus non-production workers). The measure of output differs according to the source, but in each case the output measures shown in Table 20.2 correspond conceptually to total revenue. EPA extracted the EMPLOYEE, PAYROLL, and VALUE fields for each 4-digit SIC industry in the MP&M category and for the entire state of Ohio. Industries include both in-scope and out-of-scope facilities.

Table 20.3: The Economic Censuses	
Source	**Measure of Output**
Census of Retail Trade	Value of sales
Census of Wholesale Trade	Value of sales
Census of Service Industries[a]	Value of receipts
Census of Transportation, Communications, and Utilities	Value of revenue
Financial, Insurance, and Real Estate Industries	Value of receipts
Census of Manufacturers	Value of shipments
Census of Mineral Industries	Value of shipments
Census of Construction Industries	Value of construction work

a. Includes both taxable and non-taxable establishments.
Source: Department of Commerce 1992 Economic Censuses.

The MP&M industries include facilities to which the MP&M rule may not apply. For example, MP&M industries include non-dischargers, but census data do not distinguish between in-scope and out-of-scope facilities.

Also, the analysis examines only the industrial sectors for which the Department of Commerce compiles statistics in the Economic Censuses. Published industrial employment and output measures often exclude military and other government personnel and farm output and employment, whether those exclusions are noted or not. The analysis excludes $3.9 billion in value of agricultural products sold in 1992 by farms in Ohio, according to the U.S. Department of Agriculture's 1992 Census of Agriculture. The Ohio analysis also excludes the government sector, which employed approximately 734,000 people in Ohio in 1992, according to the U.S. Bureau of Labor Statistics.[3] These exclusions are normal when economists compare the size of industrial groups.

If total employment in Ohio includes the government sector, then MP&M industries account for only 13.6 percent, rather than 16.3, percent of employment. If total industrial manufacturing and non-manufacturing output in Ohio includes the agricultural sector, then MP&M industries account for only 19.8, rather than 20.0, percent of output. This said, data from the Bureau of Labor Statistics and USDA are not completely consistent with the Economic Census data.

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[3] U.S. Bureau of the Census, *Statistical Abstract of the United States, 1993*, Washington, D.C., 1993.

EPA augmented information on MP&M facilities available from published data sources and the Section 308 survey by oversampling the State of Ohio with 1,600 screeners. The Agency used information from the Section 308 Survey and the 1,600 screeners to characterize discharges from MP&M facilities in Ohio and to assess the economic impact of the proposed regulation at the state level. Figure 20.1 depicts locations of the Ohio facilities included in the case study analysis.

The map of facility locations shows that additional information from 1,600 screeners enabled EPA to perform the benefits assessment with a greater level of detail than is possible at the national level. The added detail results in a more complete and reliable analysis of changes in human welfare resulting from improved recreational opportunities.

Figure 20.1: Location of Sample MP&M Facilities in Ohio
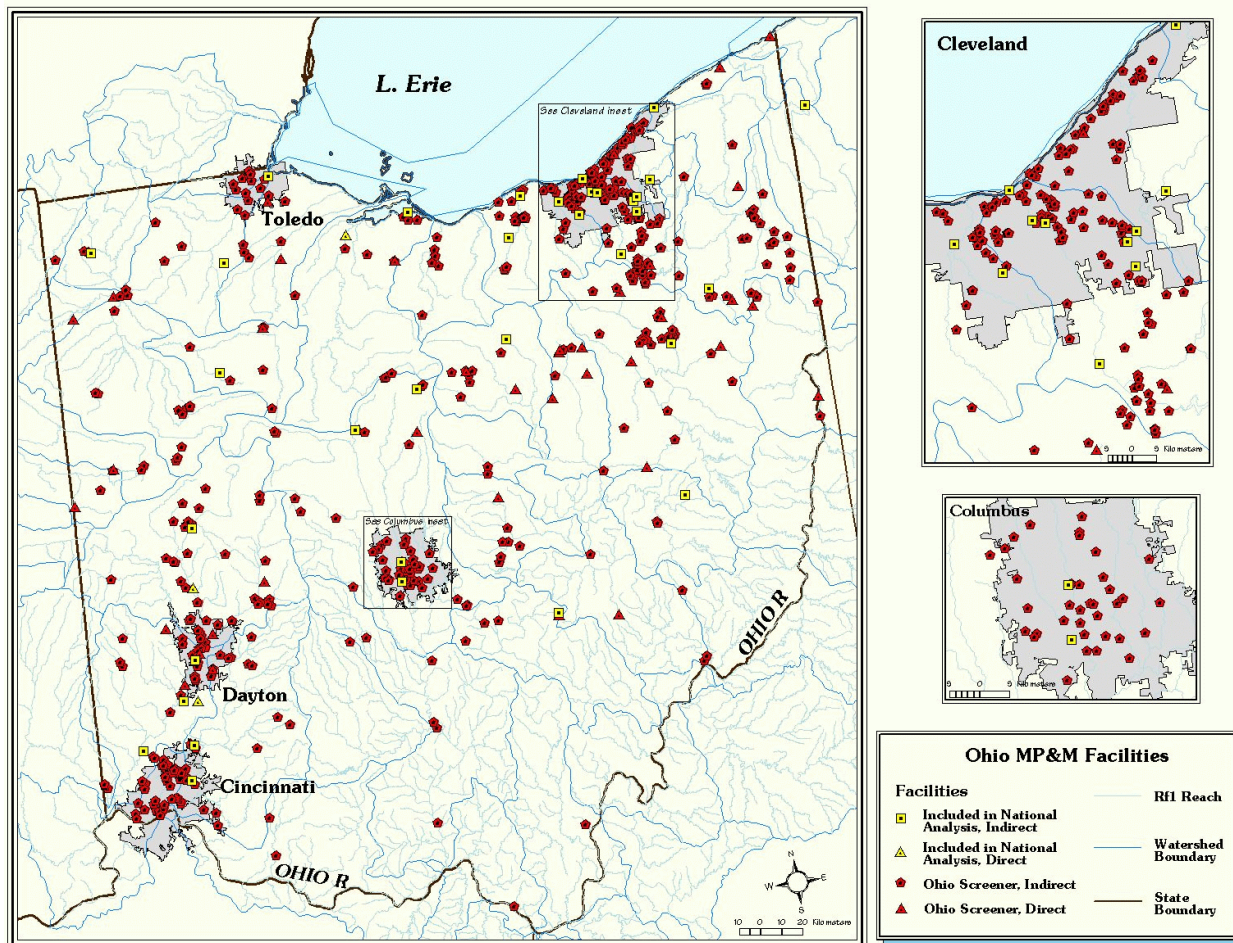
Source: U.S. EPA analysis.

20.3 OHIO'S WATER RESOURCES

The benefits of enhanced water quality stem directly from enhancing water quality and/or quantity of services provided by water resources. To aid in understanding the analysis of benefits from the proposed rule in Ohio, this section summarizes environmental services provided by Ohio's water resources.

Ohio is a water-rich state:

▸ 24,000+ miles of named and designated rivers and streams;

▸ 451-mile border on the Ohio River;

▸   200,000 acres among 450 lakes, ponds, rivers, and reservoirs; and

▸   230+ miles of Lake Erie shoreline.

These water resources provide three broad categories of services: *in-stream*, *withdrawal*, and *existence* services. Water resources provide in-stream services prior to the withdrawal of water from the waterbody. Major in-stream services include life support for animals and plants, water-based recreation, commercial fishing and navigation, water storage, and aesthetics. Withdrawal services include uses of water resources after the water is withdrawn from the waterbody. These uses include drinking water supply,

irrigation, production and processing services, and sanitary services. Existence services are not linked to current uses of waterbodies, and arise from knowing that species diversity or the natural beauty of a given waterbody is preserved.

The Ohio Environmental Protection Agency (Ohio EPA) assesses surface waters in their *Ohio Water Resource Inventory* **(OWRI)** report based on water resource services provided by the assessed waterbody. The main focus of this assessment is on beneficial uses associated with Ohio's water resources, including aquatic life use, recreation, and public water supply. Table 20.4 shows how Ohio surface waters fall into these use designations.

Table 20.4: Summary of Designated Life Uses for Ohio Surface Waters (1996)			
Use Designation	**Stream/River (Miles)[a]**	**Lakes / Reservoir (Acres)[a]**	**Lake Erie (Shore Miles)[a]**
Total	43,917	200,000	236
Aquatic Life Use[a]	24,067	193,903	236
Exceptional Warmwater Habitat (EWH)	3,217	193,903	236
Warmwater Habitat (WWH)	18,318		
Other	2,532		
Recreation			
Primary Contact (PCR)[b]	224,96	200,000	236
Secondary Contact (SCR)	1,188		
Public Water Supply		118,801	

a. Total river/stream miles are based on Ohio EPA estimates. U.S. EPA estimates 61,532 total river miles and 29,113 total perennial miles based on RF3, which includes many smaller undesignated streams.
b. Note that some waterbodies have more than one designated use (e.g., aquatic life and primary recreation).
Source: Ohio EPA, OWRI, 1996.

The aquatic life use category is further subdivided into seven categories. The most widely-applied aquatic use designation in Ohio is *Warmwater Habitat* **(WWH)**, accounting for 18,318 (76 percent) stream and river miles (Ohio EPA, OWRI, 1996). The second most widely applied designation is *Exceptional Warmwater Habitat* **(EWH)**, accounting for 3, 217 stream and river miles (13 percent), 236 Lake Erie shore miles (100 percent), and 193,903 acres of inland lakes (100 percent). Other aquatic life categories include:

▸   *Modified Warmwater Habitat* **(MWH)**,

▸   *Limited Resource Waters* **(LRW)**,

▸   *Limited Warmwater Habitat* **(LWH)**,

▸   *Seasonal Salmonid Habitat* **(SSH)**, and

▸   *Coldwater Habitat* **(CWH)**.

Recreational uses are subdivided into *Primary Contact Recreation* **(PCR)** and *Secondary Contact Recreation* **(SCR)**:

▸   Primary Contact Recreation (PCR) — rivers and streams deep enough for full human body immersion activities such as swimming.

▸   Secondary Contact Recreation (SCR) — only deep enough to permit wading and incidental contact, such as boating.

Approximately half of the designated stream miles, all inland lakes, and all of the Lake Erie shore miles are designated for PCR (see Table 20.4). In addition, three percent of the designated stream miles (1,188 miles) are suitable for SCR.

The following sections detail each category of water resource use.

20.3.1 Aquatic Life Use

The Ohio water resources support hundreds of aquatic species and plants. Ohio water resources are also home to a number of endangered and threatened species. Suitable stream and lake habitat are essential for both resident and transient animal populations, including imperiled aquatic species. Habitats include specific *biotic* components (e.g., assemblages of plant and animal species) and physical (e.g., *dissolved oxygen* **(DO)** content and temperature range) components. Water quality impairments associated with siltation, excess nutrients, or low DO can adversely affect habitat that supports important activities, such as reproduction, foraging, migration, and overwintering.

The following sections briefly introduce water-dependent biological resources Ohio. Water quality effects on life support for animals and plants are discussed in Section 20.5

a. Ohio fish species

Fish are found throughout Ohio in almost every inland surface waterbody and Lake Erie. Many fish species serve important recreational or commercial functions, while others are important forage for birds, other fish, and land-based species. Ecosystem well-being therefore depends on the health of fish and other aquatic species populations. The Ohio EPA monitors biological data, especially those on sensitive aquatic species, to determine the aquatic life use attainment of surface waters. The state gives high priority to healthy aquatic ecosystem maintenance.

Ohio's rivers and lakes offer a variety of manmade and natural habitats that offer excellent fishing opportunities for numerous gamefish species. The state of Ohio spends significant resources on fishery management, trout stocking, and recreational area maintenance to enhance these fish populations. Table 20.5 below provides brief summaries of the habitat and diet of major recreational and commercial fish species in Ohio (Ohio DNR, 1999):

Table 20.5: Recreationally or Commercially Valuable Fish Species in Ohio				
Fish	**Native or introduced?**	**Habitat**	**Spawning season**	**Diet**
Bass	Most native bass (e.g., largemouth, smallmouth, spotted, and sock)	Ponds, lakes, rivers, and streams in every county; Lake Erie	Mid-April to mid-June	Frogs, crayfish, insects, and other fish
Bullhead	Native	Throughout Ohio. Concentrations in northern and west central Ohio	Mid-May to June	Insect larvae, crayfish, snails, dead animals
Burbot	Native	Lakes and rivers. Prefer deep waters, but move inshore to spawn	Winter	Minnows and the young of other fish species
Carp	Introduced	Warm lakes, streams, and ponds with abundant organic matter, in every county	Late April to June	Insect larvae, mollusks, fish, crustaceans
Catfish (Channel, Flathead)	Native	Throughout Ohio's rivers and lakes. Tolerate a wide range of conditions	When waters reach 70° F in temperature	Bottom feeders with a diet of insect larvae, mollusks, and fish both dead and alive
Crappie, White		Larger ponds, reservoirs, and rivers, including nearshore habitats of Lake Erie, in most areas of Ohio	May and June	Insects and small fish
Crappie, Black		Same general habitat as white crappie, slightly less widely distributed	May and June	Insects and small fish
Drum	Native	Lake Erie; drums support a commercial fishery	Spring into late summer	Mollusks, crayfish, fish, insects
Lamprey		Lake Erie and tributaries; Ohio River and larger tributaries		Some species parasitize other fish by attaching themselves to a larger host's flank and feeding on its flesh

Table 20.5: Recreationally or Commercially Valuable Fish Species in Ohio				
Fish	**Native or introduced?**	**Habitat**	**Spawning season**	**Diet**
Muskellunge (Muskie)	Native	Historically found in Lake Erie bays and tributaries and streams of Ohio River drainage; now also found in several impoundments	April and early May, when temperatures reach low to mid-50s	Suckers, gizzard shard, and other soft-rayed fish
Perch, White	Introduced	Lake Erie and tributaries	April and May	Insects, crustaceans, other fish
Perch, Yellow	Native	Lakes, impoundments, ponds, slow-moving rivers		
Pike	Native	Historically abundant in Lake Erie and tributaries. Today distributed in a small portion of Lake Erie, Sandusky Bay, Maumee Bay, and their tributary streams in marshes, bays, and pools with abundant vegetation	As ice breaks in late February and early March Pike is a popular ice-fishing species	Mostly fish, but are opportunistic feeders; will occasionally eat frogs, muskrats, small ducks
Salmon (Chinook and Coho)	Introduced	Stocked in Lake Erie for both recreational and commercial fishing purposes		
Sauger	Native	Lake Erie and its tributaries; Ohio River	Spring, when water temperatures reach high 40s	Insects, crayfish, other small fish during low light (dawn and dusk)
Saugeye (cross between Sauger and Walleye)	Introduced	Stocked into many Ohio impoundments		
Sucker, White	Native	Every county; Lake Erie	April to May	Bottom feeders, consuming various plant and animal species
Sunfish	Bluegill, Pumpkinseed, Green, Warmouth, and Longear sunfish are native; Redear sunfish are introduced	Rivers, streams, and lakes throughout Ohio, and Lake Erie	Between May and August	Adults feed mostly on smaller fish, insects, crustaceans
Trout	Lake and Brook trout are native; Rainbow and Brown trout are introduced and maintained by stocking	Lake trout populations are stocked in Pennsylvania and New York and are not highly prevalent in Ohio and Lake Erie waters; Brook trout are stocked in several locations throughout Ohio		
Walleye	Native	Historically found in Lake Erie, but has been stocked in the Ohio River and reservoirs throughout the state	April	Shiners, gizzard shad, alewives, rainbow smelt
Whitefish	Native	Shallow bays of Lake Erie's western basin		Bottom feeders with a diet of mollusks and insect larvae

Source: U.S. EPA analysis.

b. Other species dependent on aquatic resources

Resident and migratory bird species make extensive use of Ohio waters. Areas along the banks or shorelines of rivers, streams, lakes, ponds, and reservoirs provide high quality nesting areas; the waters themselves are an abundant source of food. Ohio waters also serve as important staging areas for birds migrating to or from points north or south. Wading or aquatic birds are generally unaffected by water quality impairments directly. They are affected indirectly, however, through feeding on fish or invertebrates whose populations may be affected by point and nonpoint pollution sources. The regulations aimed at protecting aquatic species will therefore benefit wading and aquatic bird species indirectly. More than 130 aquatic bird species rely on Lake Erie and its tributaries. Many species are also found near inland surface waters. Major classifications of birds in Ohio include (Ohio DNR, 1999):

- ▸ Waterfowl, residing year-round in Ohio waters, especially Lake Erie. Large groups of migrating and breeding birds are also found elsewhere in the state. More than 30 species are associated with the Great Lakes area alone. All species depend on fish and crustaceans or aquatic plants for feeding. Waterfowl include loons, grebes, swans, ducks and geese. The trumpeter swan is of particular interest to Ohio, which became one of several states involved in efforts to restore these birds to the Midwest beginning in 1996 (Ohio DNR, 1999).

- ▸ Wading birds, including bitterns, herons, and egrets. These species both reside in Ohio waters and use them as breeding grounds. They use "stand-and-wait" methods to catch fish or other aquatic organisms in shallow waters. Many wading birds, such as the great egret, black-crowned night heron, and American bittern, frequent Lake Erie and surrounding areas.

- ▸ Marsh birds, including rails, moorhens, coots, and gallinules. They may feed on insects, crustaceans, mollusks, frogs, invertebrates, and small fish. These bird populations suffer from excessive development and habitat destruction. Ohio surface waters, especially those around Lake Erie, can serve as important breeding grounds for these and other bird species.

- ▸ Shore birds, including 42 species of plovers, sandpipers, gulls, and terns, in the Lake Erie and other Ohio areas. Many of them feed on aquatic organisms from Lake Erie.

- ▸ Raptors, including the bald eagle and osprey. These birds of prey rely on fishing for a large part of their diet. Bald eagles are also a nationally-listed threatened species.

- ▸ The belted kingfisher, which relies on fish in Ohio waters as a main source of food.

Ohio's biological resources also includes reptiles. Several species of lizards, snakes, and turtles depend on aquatic habitats for food and breeding. These reptiles include:

- ▸ Lizards - The Five-Lined Skink, reported in areas along Lake Erie, can be found throughout Ohio.

- ▸ Snakes - The Eastern Fox Snake, Eastern Massassasuga, Eastern Ribbon Snake, Copperbelly Water Snake, Lake Erie Water Snake, and Northern Water Snake feed within aquatic habitats.

- ▸ Turtles - The Midland Smooth Softshell Turtle and Eastern Spiny Softshell Turtle, found in the Ohio River and tributaries, are among Ohio turtles requiring aquatic habitats.

20.3.2 Water Recreation in Ohio

EPA used the 1993 *Survey of National Demand for Water-based Recreation* (NDS) (U.S. EPA, 1993) to characterize recreational uses of Ohio's water resources. The 1993 survey collected data on demographic characteristics and water-based recreation behavior using a nationwide stratified random sample of 13,059 individuals aged 16 and over. Respondents reported on water-based recreation trips taken within the previous 12 months, including the primary purpose of their trips (e.g., fishing, boating, swimming, and viewing), total number of trips, trip length, distance to the recreation site(s), and number of participants. EPA estimated recreational water use in Ohio by taking the following steps:

- ▸ Estimate the percentage of survey respondents that visited Ohio, by state.

- ▸ Apply this percentage to the total number of state residents aged 16 and over, to yield the total number of participants from each state.

- ▸ Estimate the total number of recreation trips during the 12-month period for in-state and out-of-state participants.

- ▸ Estimate the total number of recreation trips for out-of-state participants by multiplying an average number of trips per Ohio waterbody visitor by the total number of participants from each state.

- ▸ Estimate the average number of annual trips per out-of-state visitor based on the number of times

the respondents visited the site of their last recreational trip (i.e., Ohio waterbody).[4] EPA assumed that Ohio residents whose last recreation trip was in-state used Ohio waterbodies for all of their recreation trips during the 12-month period.

▸ Estimate the total number of in-state trips, summing the weighted number of recreation trips over all Ohio respondents.

EPA found that:

▸ An estimated one million individuals made about 6.3 million boating trips to Ohio waters in 1993. In-state residents made 90 percent of the boating trips.

▸ Approximately one million people visited Ohio waterbodies for recreational fishing.[5] These visitors accounted for about 15.6 million fishing trips to the area. Recreational fishermen from Ohio were the most frequent users of the state water resources, representing approximately 97 percent of all visitors.

▸ Approximately 972,000 and 896,000 visitors used the Ohio waterbodies for near-water viewing and swimming, respectively, in 1993. These visitors account for approximately 9.4 and 7.8 million viewing and swimming trips to the area. Ohio residents account for 89 percent of viewers and 93 percent of swimmers.

▸ Most out-of-state recreational users came from the states surrounding Ohio, such as Indiana, Michigan, and Pennsylvania.

20.3.3 Commercial Fishing in Ohio

Commercial fishing is a minor activity in Lake Erie: 12 license holders share a total of 19 licenses (www.lecba.org). Commercial catch data compiled by the Great Lakes Fishery Commission are summarized in Table 20.6.

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[4] NDS collected information only on the last site visited. Its numbers do not reflect people whose last visit was to a different area, but who may have also visited an Ohio waterbody on a previous trip during the year. See Section 21.3 for detail on the NDS data.

[5] EPA compared the estimated number of participants with total fishing licenses issued by Ohio in 1996. Ohio issued a total of 895,770 licenses for resident and nonresident fishing. The NDS data therefore provide relatively accurate information on participation rates.

Table 20.6: Commercial catches for Ohio Lake Erie Waters (1990)	
Fish	**Catch (1990 lbs)**
Yellow Perch	1,559,000
Carp	1,190,000
White Perch	786,000
Sheepshead	640,000
White Bass	392,000
Channel Catfish	365,000
Quillback	134,000
Buffalo	132,000
Bullheads	59,000
Suckers	41,000
Goldfish	31,000
Gizzard Shad	19,000
Lake Whitefish	10,000
Rock Bass	1,000

Source: Great Lakes Fishery Commission, www.glfc.org/fishmgmt/comdat.

Yellow perch represents about half of the dockside value for the entire commercial fishery in the Ohio waters of Lake Erie. The value of this fishery ranged from $1.3 million to $2.5 million between 1993 and 1998. Overfishing and pollution have decreased the yellow perch population throughout Lake Erie dramatically over the past 30+ years. Annual catches averaged around 20 million pounds during the 1960s and 70s. The Lake Erie Committee set the 1998 lakewide ***total allowable catch* (TAC)** quota for this species at 7.44 million pounds. The yellow perch fishery rebounded somewhat over the past couple of years, due to strong annual recruitment, strict commercial catch restrictions, and a strict creel limit of 30 fish per day for the sport angler (www.lecba.org).

20.3.4 Surface Water Withdrawals

Water resources provide a wide range of services upon being withdrawn (removed) from the waterbody. Once used, water can be returned to its original sources, returned to another waterbody, or consumed (e.g., for human drinking water). Water withdrawals from surface water averaged 9,615 mgd in 1995 (http://water.usgs.gov/watuse). The majority of this water is used in power generation, accounting for 85 percent of all surface water withdrawals. Public water supply accounts for ten percent of all withdrawals. Industrial and commercial water use account for one and four percent of the total, respectively. Water quality and quantity impairments can have substantial impacts on the key withdrawal services that water provides to a wide range of economic entities.

20.4 SURFACE WATER QUALITY IN OHIO

This section describes current water quality conditions in Ohio and the effects of water quality impairments on beneficial uses of Ohio's water resources. Ohio EPA assessed designated use attainment in approximately 42 percent of Ohio streams and rivers; approximately 64 percent of lakes, ponds, and reservoirs; and all of the Lake Erie shoreline (Ohio EPA, OWRI, 1996). The OWRI report summarizes the results of this assessment. This report provides information on designated use support by water type and use designation, identifies major pollutant/stressors that affect the quality of surface waterbodies and prevent designated use attainment, and lists major sources of impairment. The following three sections summarize findings from the 1996 OWRI report.

20.4.1 Use Attainment in Streams and Rivers in Ohio

Most waterbodies are designated for several uses and more than one use can be impaired at a time. The most commonly occurring sole impairment in fresh waterbodies is to aquatic life support. The Ohio EPA used an ecosystem approach that relies on various tools to determine aquatic life use attainment. Water chemistry, physical and habitat assessment, and direct sampling of biota all contribute to determine whether a waterbody meets an attainment status. Field data yield biological indices that eventually determine a final attainment score.

Ohio EPA assessed 6,560 perennial river miles for aquatic life use attainment. Of the 6,560 river miles assessed for aquatic life use:

▸ 38.5 percent (2,536 miles) are in full attainment, i.e., all water quality indicators meet criteria for specific waterbodies;

▸ 10.8 percent (708 miles) are in full attainment, but are threatened by pollution and other sources;

▸ 23.3 percent (1,528 miles) are in partial attainment, i.e., one of two, or two water quality indicators do not meet criteria; and

▸ 27.4 percent (1,797 miles) are in non-attainment; i.e., no criteria are met or the river experiences a severe toxic impact.

Fecal coliform bacteria counts determine recreational use attainment. Such counts are less stringent for SCR than for PCR. Ohio EPA has assessed 2,402 river miles for recreation use since 1988 (Ohio EPA, OWRI, 1996). Of the 2,402 river miles assessed for recreation use:

▸ 57 percent (1,370.3 miles) of the sampled rivers and streams are in full attainment; i.e., a waterbody meets all chemical criteria for recreational use and human contact;

▸ 19.7 percent (474.1 miles) are in partial attainment; i.e., a waterbody only partially meets human contact criteria; and

▸ 23.2 percent (557.4 miles) are in non-attainment; i.e., a waterbody fails to meet human contact criteria.

20.4.2 Lake Erie and Other Lakes Use Attainment

Lake Erie, which has a history of pollution problems, currently has fish consumption advisories for carp and channel catfish (Ohio DNR, 1999). Ohio EPA assesses Lake Erie as having partial use attainment for aquatic life and fish consumption, and full attainment for recreation.[6] Ohio EPA used parameters specified by the *Ohio EPA Lake Condition Index* (LCI) to develop use attainment for other lakes. Only approximately two percent of all lakes are in full use attainment for aquatic life, recreation, and fish consumption. Approximately 82, 50, and 53 percent are in full attainment for aquatic life, recreation, and fish consumption, respectively, but are threatened for these categories. High percentages of lake acres are in partial attainment for recreation (38.8 percent) and public supply (43.8 percent) use designations. Table 20.7 shows use attainment for Lake Erie and other lakes, ponds, and reservoirs.

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[6] Further methodologies to better assess use attainment in Lake Erie are still under development by the Ohio EPA.

Table 20.7: Use Attainment Summary for Lake Erie ane Other Lakes									
Use Category	% of Total Units Assessed	Full Attainment		Full Attainment, threatened		Partial Attainment		Non-Attainment	
	%	Units	%	Units	%	Units	%	Units	%
Lake Erie (Unit: Shore Miles)									
Aquatic Life (EWH)	100					236	100		
Recreation	100	231	98			5	2		
Fish Consumption	100					236	100		
Lakes, Ponds, & Reservoirs (Unit: Acres)									
Aquatic Life (EWH)	64.7	1,651	2.2	63,174	82.2	10,686	13.9	1,302	1.7
Recreation (PCR)	64.4	1,392	1.8	38,499	50.3	29,793	38.9	6,582	9.0
Public Water Supply	64.1	1,301	1.7	40,846	53.6	33,365	43.8	673	0.9

Assessments are based on unit of measure presented in parentheses.
Source: Ohio EPA, OWRI 1996.

20.4.3 Causes and Sources of Use Non-Attainment in Ohio

Ohio EPA assessed the causes and sources of impairment to Ohio surface waters and examined trends in major causes and sources from previous assessment cycles. The following discussion summarizes findings from the 1996 OWRI report (Ohio EPA, 1996).

a. Causes

Causes are the agents responsible for damage and threats to aquatic life. The major causes of impairment in Ohio surface waters include:

- ▸ Organic enrichment/low DO,

- ▸ Habitat modifications,

- ▸ Siltation,

- ▸ Flow alteration,

- ▸ Nutrients, and

- ▸ Metals.

Ohio EPA examined trends in these major causes from previous assessment cycles through 1996. They found that point source-related causes declined, while nonpoint sources became major contributors. Ohio EPA concluded that this trend "reflects the relative effectiveness of the programs to control point sources compared to general lack of measures to control many [nonpoint sources]" (Ohio EPA, OWRI, 1996).

Organic enrichment, which alters DO levels and affects aquatic communities, is the main cause of impairment in Ohio's rivers and streams. Inadequate wastewater treatment from municipal and industrial point sources account for most of this impairment. Metals are a major cause of impairment to approximately 226 river miles, a moderate cause of impairment to 179 river miles, and a minor cause of impairment or threat to 165 river miles.

Nutrients, resulting mostly from agricultural nonpoint sources, are the main cause of impairment in lakes. Metals are a major cause for impairment in approximately 250 acres of Ohio's lakes, ponds, and reservoirs, and form the main cause of impairment in Lake Erie, the major water resource in Ohio (90 percent of the surface water volume). Highly developed areas bordering the lake contribute urban runoff, along with discharges from industrial and municipal sources. Other causes of impairment in Lake Erie include ***priority organics***, DO, and nutrients.[7]

b. Sources

Sources are the origins of the agents responsible for damage and threats to water resources. The major sources of impairment to Ohio surface waters include:

- ▸ Municipal and industrial discharges,

- ▸ Hydromodification,

- ▸ Agricultural runoff,

- ▸ Urban runoff, and

- ▸ Mining.

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[7] Major, moderate, and minor impacts refer to the high, moderate, and slight magnitude codes specified by the U.S. EPA for the 301(b) report.

Point source-caused impairment has declined over time, while that from nonpoint sources, such as agricultural and urban runoff, has increased. Point sources remain a major source of impairment in almost 900 miles, or 25 percent, of Ohio's affected rivers and streams. Point sources are the major source of impairment for Lake Erie. They form a major source of impairment for 24 shore miles, and a moderate source of impairment for an additional 281 shore miles of Lake Erie. In addition, point sources adversely affect 1,678 lake acres.

Nonpoint sources related to agricultural and urban runoff form the major source of impairment for some 9,000 acres, or two-thirds of Ohio's lakes, ponds, and reservoirs. In addition, 46 Lake Erie shore miles list nonpoint sources as their major impairment source.

20.5 Effects of Water Quality Impairments on Water Resource Services

Water resource services are negatively affected by pollutants that impair the aquatic ecosystems. Certain pollutants can adversely affect aquatic species directly by increasing species morbidity and/or impairing reproductive success, or indirectly by adversely altering food chain interactions. These direct and indirect impacts can change quantity and type of fish and other species in the aquatic ecosystem. In the worst case scenario, an impaired ecosystem no longer supports any aquatic life. High pathogen counts or excessive eutrophication in waterbodies that are suitable for swimming may force swimmers to go elsewhere or forego swimming altogether. Any aesthetic degradation decreases the value of each individual's recreational experience. In severe cases, the affected waterbodies become unsuitable for recreation. Water quality impairments also increase the cost of treating water to meet drinking water standards.

This section details the effects of water quality impairments on in-stream services provided by Ohio's water resources.

20.5.1 Effect of Water Quality Impairment on Life Support for Animals and Plants

Deficiencies in water quantity and quality can impair the health of aquatic ecosystems. In worst case scenarios, the ecosystem may no longer support aquatic life at all. The major causes of water quality impairment in Ohio include high *biological oxygen demand* (BOD) from organic enrichment, habitat and flow alterations, nutrients, *siltation* and *turbidity*, *metals*, *pH*, *ammonia*, and priority organics. Habitat, flow alterations, and thermal discharges are unrelated to MP&M effluents and are not discussed

here. MP&M effluents contribute to the remaining major causes of water quality impairment, with the ecological effects outlined below.

a. BOD/COD

BOD and *chemical oxygen demand* (COD) are two methods to determine the oxygen requirements of pollutants in wastewater. Low oxygen level is the primary cause of impairment in Ohio's rivers and streams and a major course of impairments in Ohio's lakes. When bacteria decompose excess organic matter, they consume DO in surface waters. Oxygen is needed to chemically (abiotically) oxidize the pollutants present in wastewater. When too much oxygen is needed to oxidize pollutants, hypoxic (oxygen deficient) or anoxic (oxygen depleted) conditions result. Sources of high oxygen demand include effluents from municipal treatment plants and certain industries, and runoff from feedlots or farms. Another source is *eutrophication* caused by excessive nutrient input. The nutrients stimulate algal blooms. Bacteria consume the algae when they die, decreasing DO in the water column. DO is a critical variable for fish and invertebrate survival. If oxygen concentrations drop below a minimum level, organisms suffocate and either move out or die (EPA, 1986). This effect can drastically reduce the amount of useable aquatic habitat.

b. Nutrients

Nutrients are the leading causes of impairment in Ohio lakes and comprise one of the major causes of impairment in rivers, streams, and Lake Erie. The overabundance of nitrogen and phosphorus is one of the most documented forms of aquatic ecosystem pollution. Although both compounds are essential nutrients for phytoplankton (free-floating algae) and periphyton (attached algae), which form the base of the aquatic food web, too much nutrient input overstimulates primary productivity and results in eutrophication. The impact of these compounds has contributed significantly to water quality decline in the United States (EPA, 1992). Phosphorus is a limiting nutrient in most freshwater systems (Wetzel, 1983), whereas nitrogen is typically limited in estuarine and marine systems.

In freshwater, excess phosphate (PO_4) has been linked to eutrophication and nuisance growth of algae and aquatic weeds (Wetzel, 1983), even though direct toxicity to fish and other aquatic species is not a major concern. DO in the water column decreases, however, when algae and other aquatic plants die off, and certain toxins may be produced, both of which can contribute to fish kills.

c. Siltation and turbidity

Siltation and turbidity are the third leading causes of impairments in Ohio rivers and lakes, except Lake Erie. Siltation is the most important factor in surface water degradation in the U.S. (EPA, 1992). Major sources include urban and storm water runoff, mining and logging activities,

and runoff from plowed fields (EPA, 1992). All these inputs create cloudy water with increased turbidity and decreased visibility and light penetration. High primary productivity by phytoplankton following excessive nutrient input can also increase turbidity. Excess suspended matter decreases the amount of light penetrating the water column, which can reduce primary productivity. This turbidity can eliminate or displace fish species requiring clear water to live, feed, or reproduce.

d. Metals

Metals are the leading cause of impairment in Lake Erie and comprise one of the major causes of impairment in inland lakes and rivers. Metals are naturally-occurring inorganic constituents of the earth's crust. Priority pollutant metals commonly found in the aquatic environment include antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium and zinc (EPA, 1998a). These compounds enter the aquatic environment via urban stormwater runoff, industrial and municipal effluents, and atmospheric deposition. As a group, metals can be highly toxic: *water quality criteria* **(WQC)** for acute toxicity range from around 1,100 μg/l (chromium VI in salt water) to around 1 μg/l (mercury in freshwater); WQC for chronic toxicity range from 120 μg/l (zinc in freshwater) to <1.0 μg/l (mercury in salt- and freshwater) and are therefore an order of magnitude lower (EPA, 1998a).

Once metals reach the aquatic environment, they tend to associate with organic and inorganic particulates in the water column. Sediments become long-term sinks for metals, which accumulate in the bottom. Metals can enter the food chain when ingested by benthic invertebrates or other burrowing organisms. Most metals have *bioconcentration factors* **(BCFs)** ranging from 100 to 10,000 and can therefore bioaccumulate in aquatic organisms. A few, including selenium, lead, and mercury, may reach hazardous levels in fish or wildlife receptors and result in avian developmental or neurological abnormalities.

e. Organic chemicals

Priority organics are the second most frequent cause of impairment in Lake Erie and comprise one of the major causes of impairment in rivers and streams. Thousands of different compounds exist as organic chemicals, including petroleum hydrocarbons and myriad industrial chemicals. They enter the aquatic environments via municipal and industrial effluents, stormwater runoff, contaminated groundwater, atmospheric deposition, illegal dumping, or accidental releases. Aquatic toxicities vary by orders of magnitude depending on the compound. Factors influencing toxicity and long-term ecological effects include water solubility, volatility, biodegradation potential, and bioaccumulation potential.

Excessive amounts of organic chemicals degrade surface water quality by causing acute or (more typically) chronic toxicity. This toxicity impairs growth, development, and/or reproductive success in fish and aquatic invertebrates. Persistent and low water-soluble organic chemicals accumulate in sediments and are taken up into local aquatic food chains. They can reach dangerous concentrations in fish and avian receptors, resulting in reproductive failures or other avian health effects.

f. pH

Approximately 180 river miles are pH-impaired in Ohio. pH is a measure of acidity. Acid reaches surface waters via atmospheric deposition ("acid rain"), industrial effluents, and leachates from mine *overburdens* or spoils. Acidity by itself is a key variable shaping aquatic communities: it is a toxicant in its own right but also controls metal solubility, and the toxicity of several metals and ammonia.

Aquatic species vary widely in their sensitivity to pH: the most sensitive vertebrate and invertebrate species die off when average pH ranges between 6.0 and 6.5. Most fish species are eliminated when pH reaches 5.0. Only a few can survive at pH 4.5 (U.S. EPA, 1999). Macro invertebrates exhibit the same pattern, except that hardy species can survive down to a pH of about 3.5.

g. Ammonia

Large amounts of ammonia enter lakes and rivers via wastewater treatment plants and industrial effluents, atmospheric deposition, and nonpoint surface runoff. Approximately 150 river miles in Ohio are ammonia-impaired. This compound, unique among regulated pollutants, is also produced naturally inside fish as a metabolic waste product. Excess ammonia usually diffuses rapidly out of the blood stream and into the surrounding water via the gills. High concentrations of external *unionized* ammonia (NH_3) reduce or reverse this diffusive gradient and allow ammonia to build up to toxic levels inside the organism (EPA, 1998c).

Ammonia in surface water exists in two major forms: un-ionized ammonia (NH_3), which is highly toxic to fish or invertebrates, and ammonium ion (NH_4^+), which is much less toxic. Which form prevails depends mainly upon the pH level; temperature and ionic composition play a smaller role. EPA calculated a WQC that becomes more severe with decreasing acidity. For example, the acute criteria for surface waters containing salmonids equals 36.7 mg/l at pH=6.0 but only 2.14 mg/l at pH=8.5. For surface waters without salmon, the acute criteria for the same pH equal 55.0 mg/l and 3.2 mg/l, respectively (EPA, 1998c).

20.5.2 Effect of Water Quality Impairment on Recreational Services

Healthy surface waters are essential to support a diversity of recreational uses, including viewing and other near-water activities. Industrial or other human activities impair surface

water quality. Certain metals and chlorinated compounds can bioaccumulate in aquatic food chains and reach unhealthy levels in carnivorous fish or shellfish. Health advisories to limit or avoid their consumption may result. High concentrations of toxic compounds can also lead to human contact advisories. The release of untreated or poorly treated sewage can cause high levels of pathogenic bacteria in water and result in swimming advisories or beach closures. All of these actions limit the full use of surface waters and can have significant local economic impacts.

a. Fish consumption advisories

In 1997, the **Ohio Department of Health (ODH)** issued a statewide fish consumption advisory to protect women of childbearing age and children six years or younger against mercury's neurological and developmental effects. The advisory, which applies only to these two population groups, recommended that these women and children eat no more than one meal per week of any fish caught in Ohio waters. The advisory covers all state waters because most of the mercury measured in fish tissues originates from region-wide fossil fuel combustion processes. The mercury reaches surface waters via atmospheric deposition on the surrounding landscape (Ohio DNR, 1999).

Since 1983, the ODH has developed numerous waterbody-specific fish consumption advisories for approximately 174 waterbody segments (rivers and lakes) and Lake Erie. These waterbodies represent a relatively small fraction of Ohio's 5,000 discrete waterbody segments, as determined by Ohio EPA. The contaminants of greatest concern include **polychlorinated biphenyls (PCBs)**, mercury, **polycyclic aromatic hydrocarbons (PAHs)**, lead, organometallics, Mirex, phthalate esters, Chlordane, and hexachlorobenzene. Of these, four — mercury, PAHs, lead, and phthalates — are included on the MP&M list of **pollutants of concern (POCs)**. As a group, these contaminants are generally characterized as lipophilic (i.e., fat loving), resistant to biological degradation or cellular metabolism, and toxic. Once they reach surface water, they concentrate in sediments and bioaccumulate or biomagnify through aquatic food chains. These compounds can linger for decades in aquatic systems.

The kind of sports or recreational fish species affected by the consumption advisories varies by waterbody segment. More than 23 different species are covered by advisories, including walleye, common carp, sauger, saugeye, white crappie, freshwater drum, and various species of bass, perch, catfish, salmon, trout, suckers, and sunfish. Restrictions vary depending on the pollutant, the fish species concerned, and the concentrations measured in edible tissues. The ODH developed maximum recommended rates of fish consumption that include outright consumption bans, one meal every two months, one meal a month, or one meal a

week. The same waterbody segments can commonly have different advisories for different fish species (Ohio DNR, 1999).

b. Contact advisories

The ODH also issued human contact advisories for nine waterbody segments in Ohio located on the Black River, Little Scioto River, Mahoning River, the middle fork of the Little Beaver Creek, and the Ottawa River. Swimming or wading is prohibited due to the presence of high levels of PAHs, PCBs, Mirex, phthalate esters, and/or Chlordane. Of these, PAHs and phthalates are included on the list of MP&M POCs. Fish consumption advisories also cover all of these segments (Ohio DNR, 1999).

c. Beach closures

Beach closures typically occur during the summer months when high levels of fecal coliform bacteria or other disease-causing organisms (e.g., *Escherichia coli*) proliferate in surface waters. Such waters can become contaminated from several sources, including: agricultural runoff, sewer overflows, boating wastes, and poor hygienic practices by some bathers. Excessive levels of indicator pathogens in surface waters can indicate a serious threat to human health and may cause health departments to post warnings, restrict access, or forbid swimming altogether. The MP&M regulation is not expected to reduce beach closures during summer months.

Numerous public bathing beaches dot Ohio's 262-mile shoreline along Lake Erie. The ODH has developed a composite metric based on *E. coli* counts in surface waters at 11 selected beaches along Ohio's north coast. The metric tracks the average number of days that swimming advisories are posted at the 11 beaches for a 15 week period beginning around Memorial Day and continuing through Labor Day. The most recent data available show that the 11 beaches were under advisement an average of 21 days during the summer months (minimum of 0 days and maximum of 49 days) in 1996.

The ODH developed a 4-tiered scale to score and track the average number of days that the 11 public beaches are under advisement from one year to the next. Between 1990 and 1996, the average (based on a five-year running average) number of beach advisories scored in the "fair" category consistently, meaning that the beaches were under advisement between 20 and 30 days in the summer (State of Ohio, 1998).

Ohio's lakes, ponds and reservoirs (excluding Lake Erie) yielded no quantitative data on beach closures. The 1996 Ohio Water Resource Inventory of Public Lakes, Ponds and Reservoirs provides a breakdown of the portion of Ohio's 446 public lakes that are threatened or impaired as a result of high levels of fecal coliform bacteria.

20.6 PRESENCE AND DISTRIBUTION OF ENDANGERED AND THREATENED SPECIES IN OHIO

Many factors can affect the survival of **endangered and threatened (E&T)** species. Some factors are species-specific; others result from one or more anthropogenic stressors. Inherent vulnerability factors include narrow geographic distribution, slow reproductive rates, or requirements for large areas. Major anthropogenic stressors include intentional taking (e.g., fishing), incidental taking, physically altering habitat (e.g., converting wetlands into agricultural land), water pollution, and introducing alien species. A single stressor or a set of stressors can contribute to a species' decline or extinction. Previous studies reported that more than 40 percent of endangered aquatic species were affected by five or more environmental stressors, and only seven percent of federally-listed species had a single threat to their survival. Although stressors seldom act alone, water pollution is one of the major hazards to E&T aquatic species, cited as responsible for the decline of 19 (54 percent) out of 35 E&T fish species in Ohio (Ohio DNR, 1998).

The following sections provide an overview of E&T species found in Ohio, their distribution, and the major hazards threatening their survival. Species discussed below include those listed under both the federal **Endangered Species Act** (50 CFR Part 17) and the **Ohio Department of Natural Resources'(DNR)** Division of Natural Areas and Preserves. The MP&M regulation concentrates on water-related benefits; these sections therefore describe only those species associated with aquatic environments.[8] The DNR list includes 90 E&T species with a total of 1,227 observations throughout Ohio. "Observations" refers to locations where species were observed; most species have multiple observations. This analysis includes observations spanning the years 1980 to 1988.

20.6.1 E&T Fish

E&T fish inhabit almost every major waterbody in Ohio, including Lake Erie and the Ohio River and its tributaries. The Ohio DNR lists 35 total state-listed E&T fish species, of which 13 are threatened and 22 endangered. The list includes only one federally-listed species, the Scioto Madtom.

Of the total E&T fish, approximately 12 species use Lake Erie as a possible habitat and nine use the Ohio River. Most of the species listed live in riverine habitats. Approximately 28 species were identified in a river system in Ohio, including the Ohio, Scioto, Muskingham, Miami, Walhondig, and Maumee River systems. MP&M facilities are found on all these major river systems.

The DNR lists 384 observations of E&T fish in Ohio, of which 240 observations of 30 different species have been reported since 1980. Figure 20.2 maps the observations of E&T fish in Ohio and shows the extent to which these observations were reported in the state. Multiple observations can occur for a single species. In southern Ohio, most observations come from the Muskingham and Scioto River systems and the Ohio River. Most observations in northern Ohio came from Lake Erie tributaries or the lake itself.

In addition to water pollution, cited above as major hazard to E&T aquatic species, other major hazards to E&T fish include siltation and impoundments. Approximately two-thirds of E&T fish species are threatened by siltation, and 17 percent are threatened by impoundments or dams. MP&M regulations can improve affected ecosystems or habitats by reducing discharges from MP&M facilities. These improvements can then help reduce siltation and restore some of the E&T fish populations.

Many obscure E&T fish species have a pure existence value. Some E&T species, like brook trout and lake sturgeon, have high potential for consumptive uses. Restoring their populations and those of other commercial and recreational fish species may enhance recreational fishing opportunities. Table 20.8 lists E&T fish in Ohio, their habitat locations, and the cause for their E&T listing. The table lists species alphabetically by scientific name.

20.6.2 E&T Mollusks

Mollusks yield the largest number of reported observations of aquatic E&T species in Ohio, representing 48 percent of the total 1,227 observations. The Ohio DNR lists 29 E&T mollusk species, four threatened and 25 endangered. Of these, five mollusk species are on the federal endangered species list: Catspaw, Clubshell, Fanshell, White Catspaw, and Pink Mucket. Ohio's E&T mollusks concentrate in five major areas: Lake Erie and the Grand River tributary, Scioto River and Big Darby tributary, Muskingham River, Little Miami River, and the Ohio River. E&T mollusk populations reside mostly along the mainstems of large rivers and in Lake Erie, but are also found in the St. Joseph, Sandusky, and Cuyahoga Rivers.

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[8] "Aquatic species" were identified by the Ohio Department of Natural Resources, Division of Natural Areas and Preserves. These species include any species that are "closely associated with aquatic habitats through their breeding or feeding requirements."

Figure 20.2: E&T Fish Observances in Ohio
(1980-1997)
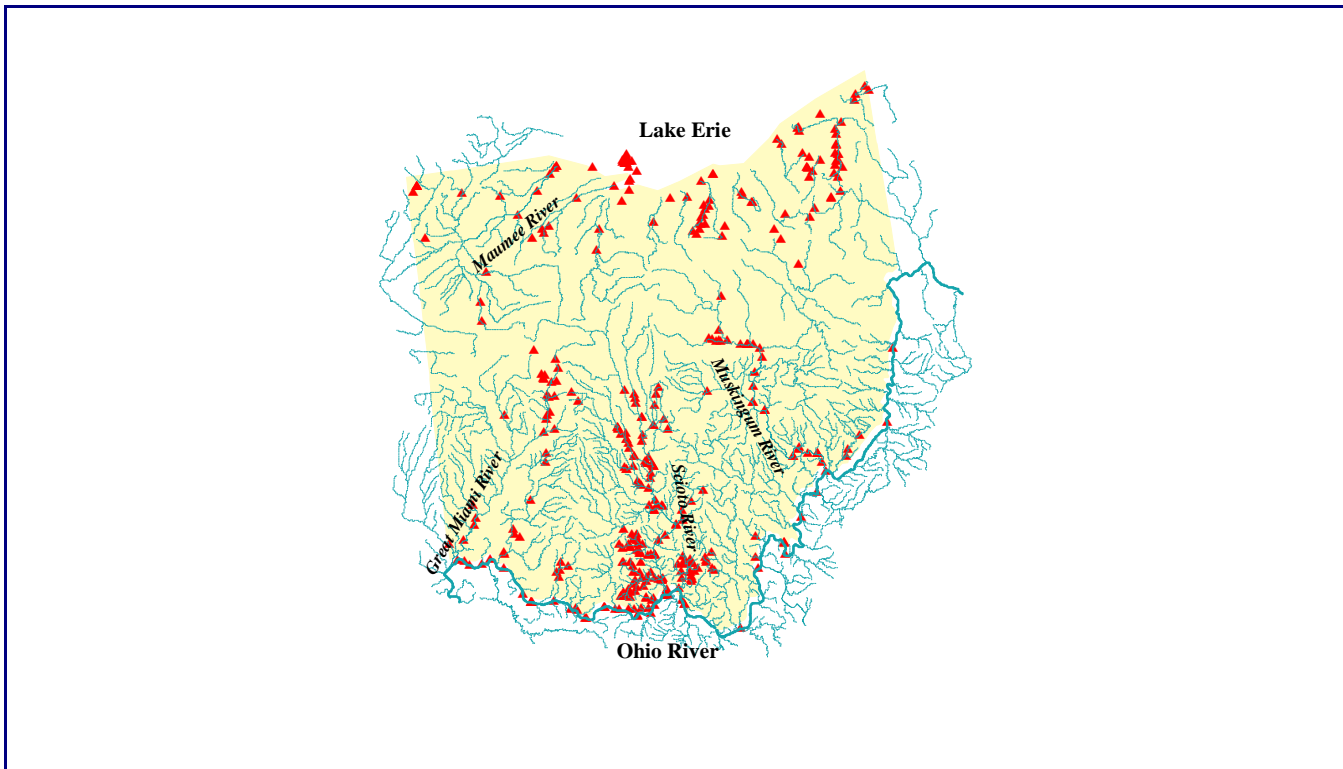
Source: U.S. EPA analysis.

20.6.3 Other Aquatic E&T Species

Improved water quality resulting from the MP&M regulation may also benefit other aquatic E&T species. Unlike fish and mollusks, whose primary habitat is a surface waterbody at all times, these species may use only surface water-related habitats for breeding or feeding. Improved water quality may benefit these populations indirectly by enhancing the quality and quantity of aquatic biological resources.

Other aquatic-associated E&T species of Ohio include:

▸ Birds — ten state-listed species, one threatened and nine endangered, include one federally-listed threatened species, the Bald Eagle. The state-listed species include: American and Least Bitterns, Common and Black Terns, Yellow- and Black-Crowned Night-Herons, King Rail, Osprey, and Snowy Egret. These species are observed mostly along the Lake Erie coast. The Bald Eagle is observed mostly in Ohio's northeast corner.

▸ Amphibians — three state-listed endangered species: Blue-Spotted Salamander, observed in the very northwest section of the state along small

streams and near the Maumee River; Eastern Spadefoot, found near the Ohio and Muskingham Rivers; and Eastern Hellbender, observed along the Muskingham and Scioto River systems and tributaries of the Ohio River.

▸ Reptiles — two species: the Copperbelly Water Snake, a state-listed endangered and federally-listed threatened species found in lakes and ponds in the northwest corner of Ohio; and the Lake Erie Water Snake, state-listed as threatened and a proposed threatened species for the federal list, found only along the edges of the Lake Erie islands.

▸ Mammals — the River Otter is state-listed as endangered. Sparse observations of the animal come from various small creeks and lakes in the eastern part of Ohio.

▸ Crustaceans — the state-listed endangered Sloan's Crayfish has been observed in several small tributaries of the Great Miami River system.

▸ Insects — nine state-listed species, one threatened and eight endangered, are reported throughout the state.

Table 20.8: Endangered and Threatened Fish Species of Ohio

Common Name	Scientific Name	Number of Observations	Last Observed	Federal Status	State Status	Habitat	Causes for Listing
Lake Sturgeon	*Acipenser fulvescens*	3	1979		E	Lake Erie, spawning in larger rivers such as Maumee and Auglaize	Pollution and dams
Longnose Sucker	*Catostomus catostomus*	1	1950		E	Lake Erie	Pollution creating low-oxygen levels
Rosyside Dace	*Clinostomus funduloides*	53	1997		T	Small, upland streams of Teays and Little Scioto River systems	Runoff and siltation
Cisco	*Coregonus artedi*	1	1976		E	Lake Erie	Pollution and overfishing
Blue Sucker	*Cycleptus elongatus*	2	1985		E	Ohio River and lower reaches of large tributaries	Pollution, dams, increases in turbidity and siltation
Lake Chubsucker	*Erimyzon sucetta*	28	1994		T	Lakes (not Erie) and larger streams	Increased turbidity and siltation
Bluebreast Darter	*Etheostoma camurum*	19	1995		T	Scioto and Muskingham River systems, large streams	Pollution and siltation
Spotted Darter	*Etheostoma maculatum*	8	1992		E	Large streams of Muskingham and Scioto systems	Pollution and siltation
Tippecanoe Darter	*Etheostoma tippecanoe*	11	1994		T	Muskingham and Scioto River systems	
Tonguetied Minnow	*Exoglossum laurae*	16	1996		T	Great Miami River system	Undetermined, likely pollution and siltation
Western Banded Killifish	*Fundulus diaphanus menona*	9	1994		E	Lake Erie and larger tributaries	Siltation
Goldeye	*Hiodon alosoides*	16	1989		E	Ohio River and lower reaches of large tributaries	Pollution
Mississippi Silvery Minnow	*Hybognathus nuchalis*	1	1983		E	Ohio River and tributaries	Siltation
Ohio Lamprey	*Ichthyomyzon bdellium*	4	1992		E	Ohio River and lower reaches of large tributaries	Pollution and siltation
Northern Brook Lamprey	*Ichthyomyzon fossor*	25	1992		E	Small streams, tributaries of Grand and Scioto rivers	Pollution, siltation, and dams
Mountain Brook Lamprey	*Ichthyomyzon greeleyi*	6	1993		E	Mahoning River and tributaries	Pollution, siltation, and dams
Silver Lamprey	*Ichthyomyzon unicuspis*	40	1993		T	Lake Erie and larger tributaries	Pollution, siltation, and dams
Blue Catfish	*Ictalurus furcatus*	1	1987		E	Scioto River	
Spotted Gar	*Lepisosteus oculatus*	1	1978		E	Lake Erie	Siltation and dredging
Shortnose Gar	*Lepisosteus platostomus*	9	1981		E	Scioto River and tributaries	Pollution and siltation
Speckled Chub	*Macrhybopsis aestivalis*	1	1990		E	Ohio and Muskingham rivers, large rivers	Pollution and siltation
Greater Redhorse	*Moxostoma valenciennesi*	12	1989		T	Maumee river system, large streams	Pollution and siltation
Popeye Shiner	*Notropis ariommus*	4	1993		E	Extirpated from Ohio, creeks and small rivers of Maumee system	Siltation
Bigeye Shiner	*Notropis boops*	22	1995		T	Great Miami River and Ohio River systems, upland streams	Siltation and impoundments

Table 20.8: Endangered and Threatened Fish Species of Ohio							
Common Name	Scientific Name	Number of Observations	Last Observed	Federal Status	State Status	Habitat	Causes for Listing
Bigmouth Shiner	*Notropis dorsalis*	16	1994		T	Black and Rocky river systems, brooks and small streams	Competition with silver minnow
Blackchin Shiner	*Notropis heterodon*	2	1983		E	Lake Erie and other lakes	Increased turbidity and siltation
Blacknose Shiner	*Notropis heterolepis*	7	1983		E	Lake Erie and other lakes	Siltation
Mountain Madtom	*Noturus eleutherus*	11	1991		E	Ohio River tributaries, larger streams and rivers	Pollution and siltation
Northern Madtom	*Noturus stigmosus*	10	1989		E	Muskingham, Little Miami, Walhondig Rivers	
Scioto Madtom	*Noturus trautmani*	1	1957	E	E	Big Darby Creek, tributary of Scioto	Pollution and siltation
Pugnose Minnow	*Opsopoeodus emiliae*	6	1982		E	Lakes, canals, streams, and Lake Erie	Increased turbidity and siltation
Channel Darter	*Percina copelandi*	18	1991		T	Lake Erie and Ohio River	Siltation
River Darter	*Percina shumardi*	8	1989		T	Lake Erie and larger tributaries of Ohio River	Pollution and siltation
Paddlefish	*Polyodon spathula*	11	1996		T	Ohio River tributaries, larger streams and rivers	Pollution and siltation
Brook Trout	*Salvelinus fontinalis*	1	1997		T	Tributaries of Lake Erie	Habitat destruction - timbering and non-native species

Source: Division of Natural Areas and Preserves, Ohio Department of Natural Resources, Natural Heritage Program 1998

GLOSSARY

ammonia: a compound of nitrogen and hydrogen (NH_3). It is a colorless, pungent gas.

biological oxygen demand (BOD): the amount of dissolved oxygen consumed by microorganisms as they decompose organic material in polluted water.

bioconcentration factors (BCFs): indicators of the potential for chemicals dissolved in the water column to be taken up by aquatic biota across external surface membranes, usually gills.

biotic: pertaining to the characteristics of a naturally occurring assemblage of plants and animals that live in the same environment and are mutually sustaining and interdependent.

chemical oxygen demand (COD): The amount of oxygen consumed in the complete chemical oxidation of matter, both organic and inorganic, present in polluted water.

Coldwater Habitat (CWH): a designation assigned to a waterbody based on the potential aquatic assemblage.

conventional pollutants: biological oxygen demand (BOD), total suspended solids (TSS), oil and grease (O&G), pH, and anything else the Administrator defines as a conventional pollutant.

dissolved oxygen (DO): oxygen freely available in water, vital to fish and other aquatic life and for the prevention of odors. DO levels are considered a most important indicator of a waterbody's ability to support desirable aquatic life. Secondary and advanced waste treatment are generally designed to ensure adequate DO in waste-receiving waters. (http://www.epa.gov/OCEPAterms/dterms.html)

endangered and threatened (E&T): animals, birds, fish, plants, or other living organisms threatened with extinction by anthropogenic (i.e., man-caused) or other natural changes in their environment. The Endangered Species Act contains requirements for declaring a species endangered.

Endangered Species Act: federal legislation enacted in 1973 that protects animals, birds, fish, plants, or other living organisms threatened with extinction by anthropogenic or other natural changes in their environment. For a species to be protected under this act it must be "listed" as either an "endangered" or "threatened" species.

eutrophication: process by which bodies of water receive increased amounts of dissolved nutrients, such as nitrogen and phosphorus, that encourage excessive plant growth and result in oxygen depletion.

Exceptional Warmwater Habitat (EWH): the aquatic life use designed to protect aquatic communities of exceptional diversity and biotic integrity. Such communities typically have a high species richness; often include strong populations of rare, endangered, threatened, and declining species; and/or are exceptional sport fisheries.

existence: services that are not linked to current uses of waterbodies. They arise from the knowledge that species diversity or the natural beauty of a given waterbody is being preserved.

in-stream: water use taking place within the stream channel for purposes such as life support for animals and plants, water-based recreation, hydroelectric power generation, navigation, commercial fishing, water storage, and aesthetics.

Limited Resource Waters (LRW): an aquatic life use assigned to streams with very limited aquatic life potential, usually restricted to highly acidic mine drainage streams, or highly modified small streams (<3 sq. mi. drainage area) in urban or agricultural areas with little or no water during the summer months.

Limited Warmwater Habitat (LWH): see limited resource waters.

metals: inorganic compounds, generally non-volatile (with the notable exception of mercury), that cannot be broken down by biodegradation processes. They are of particular concern due to their prevalence in MP&M effluents. Metals can accumulate in biological tissues, sequester into sewage sludge in POTWs, and contaminate soils and sediments when released into the environment. Some metals are quite toxic even when present at relatively low levels.

μg/l: micrograms per liter.

Modified Warmwater Habitat (MWH): aquatic life use assigned to streams that have irretrievable, extensive, man-induced modifications that preclude attainment of the Warmwater Habitat use, but which harbor the semblance of an aquatic community. Such waters are characterized by poor chemical quality (low and fluctuating dissolved oxygen), degraded habitat conditions (siltation, habitat simplification), and species that are tolerant of these effects.

nonconventional pollutants: a catch-all category that includes everything not classified as either a priority or conventional pollutant.

nutrients: any substance, assimilated by living things, that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements. (http://www.epa.gov/OCEPAterms/nterms.html)

Ohio EPA Lake Condition Index (LCI): an ecologically-based index that aggregates results across ten ecological metrics.

Ohio Water Resource Inventory (OWRI): a biennial report to U.S. EPA and Congress required by Section 305(b) of the Clean Water Act. The report is composed of four major sections: (1) inland rivers and streams, wetlands, Lake Erie, and water program description; (2) fish tissue contaminants; (3) inland lakes, ponds, and reservoirs; and (4) groundwater.

overburdens: rock and soil cleared away before mining. (http://www.epa.gov/OCEPAterms/oterms.html)

pH: an expression of the intensity of the basic or acid condition of a liquid; Natural waters usually have a pH between 6.5 and 8.5. (http://www.epa.gov/OCEPAterms/pterms.html)

pollutants of concern (POCs): the 131 contaminants identified by EPA as being of potential concern for this rule and that are currently being discharged by MP&M facilities. EPA used fate and toxicity data, in conjunction with various modeling techniques, to identify these pollutants and assess their potential environmental impacts on receiving waterbodies and POTWs. MP&M pollutants of concern include 43 priority pollutants, 3 conventional pollutants, and 86 non-conventional pollutants.

polychlorinated biphenyls (PCBs): group of toxic, persistent chemicals that are mixtures of chlorinated biphenyl compounds having various percentages of chlorine. PCBs are industrial chemicals formerly used in electrical transformers and capacitors for insulating purposes, and in gas pipeline systems as a lubricant.

polycyclic aromatic hydrocarbons (PAHs): class of organic compounds with a fused-ring aromatic structure. PAHs result from incomplete combustion of organic carbon (including wood), municipal solid waste, and fossil fuels, as well as from natural or anthropogenic introduction of uncombusted coal and oil. PAHs include benzo(a)pyrene, fluoranthene, and pyrene.

Primary Contact Recreation (PCR): water recreation activities requiring full human body immersion, such as swimming, diving, water skiing, and surfing.

priority organics: prority pollutants that are organic chemicals.

priority pollutants: 126 individual chemicals that EPA routinely analyses when assessing contaminated surface water, sediment, groundwater, or soil samples.

random utility model (RUM): a model of consumer behavior. The model contains observable determinants of consumer behavior and a random element.

Secondary Contact Recreation (SCR): water recreation activities requiring some direct contact with water but where swallowing of water is unlikely, such as paddling, wading, and boating.

siltation: deposition of finely divided soil and rock particles on the bottom of stream and river beds and in reservoirs.

Survey of National Demand for Water-based Recreation (NDS): a U.S. EPA survey of recreational behavior. The 1993 survey collected data on socioeconomic characteristics and water-based recreation behavior using a nationwide stratified random sample of 13,059 individuals aged 16 and over (http://www.epa.gov/opei).

total allowable catch (TAC): amount of fish permitted to be removed under a fishery management regime in which the total catch allowed of a certain species for a fishing season has been fixed in advance.

"toxic" pollutants: refers to the 126 priority or toxic pollutants specifically defined as such by EPA, as well as nonconventional pollutants that have a toxic effect on human health or aquatic organisms.

turbidity: cloudy condition in water that interferes with the passage of light through the water column. It is caused by the presence of suspended silt or organic matter in the waterbody.

unionized: neutral form of an ionizable compound. With reference to ammonia, it is the neutral form of ammonia-nitrogen in water, usually occurring as NH_4OH. Unionized ammonia is the principal form of ammonia that is toxic to aquatic life. The relative proportion of unionized to ionized ammonia (NH^{4+}) is controlled by water temperature and pH.

Warmwater Habitat (WWH): a designation assigned to a waterbody based on the potential aquatic assemblage.

water quality criteria (WQC): specific levels of water quality that, if reached, are expected to render a body of water suitable for certain designated uses.

withdrawal: water removed from the ground or diverted from a surface-water source for uses such as drinking water supply, irrigation, production and processing services, and sanitary services.

ACRONYMS

BCFs: bioconcentration factors
BOD: biological oxygen demand
COD: chemical oxygen demand
CWH: Coldwater Habitat
DO: dissolved oxygen
E&T: endangered and threatened
EWH: Exceptional Warmwater Habitat
LRW: Limited Resource Waters
LWH: Limited Warmwater Habitat
MWH: Modified Warmwater Habitat
ODH: Ohio Department of Health
DNR: Ohio Department of Natural Resources
LCI: Ohio EPA Lake Condition Index

OWRI: Ohio Water Resource Inventory
POCs: pollutants of concern
PCBs: polychlorinated biphenyls
PAHs: polycyclic aromatic hydrocarbons
PCR: Primary Contact Recreation
RUM: random utility model
SSH: Seasonal Salmonid Habitat
SCR: Secondary Contact Recreation
NDS: Survey of National Demand for Water-based Recreation
TAC: total allowable catch
WWH: Warmwater Habitat
WQC: water quality criteria

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